In the Specification

Please make the following amendments that are provided by replacement paragraphs. The replacement paragraphs are identified by page and beginning line number. Marked-up versions of the amendments to the specification follow the remarks section of this response.

The paragraph on page 1, beginning on line 4:

This invention relates to Coriolis flowmeters. More particularly, this invention relates to reducing a flag dimension of a Coriolis flowmeter by using flow tubes having a substantially semicircular arc and one set of brace bars. Still more particularly, this invention relates to a configuration of components that maintains zero stability and reduces the amplitude of the vibrating flow tubes to reduce stress applied to the brace bars.

A1

The paragraph on page 1, beginning on line 12:

It is known to use Coriolis effect mass flowmeters to measure mass flow and other information of materials flowing through a pipeline as disclosed in U.S. Patent Nos. 4,491,025 issued to J.E. Smith, et al. of January 1, 1985 and Re. 31,450 to J.E. Smith of February 11, 1982. These flowmeters have one or more flow tubes of a curved configuration. Each flow tube configuration in a Coriolis mass flowmeter has a set of natural vibration modes, which may be of a simple bending, torsional, or coupled type. Each flow tube is driven to oscillate at resonance in one of these natural modes. The natural vibration modes of the vibrating, material filled system are defined in part by the combined mass of the flow tubes and the material within the flow tubes. Material flows into the flowmeter from a connected pipeline on the inlet side of the flowmeter. The material is then directed through the flow tube or flow tubes and exits the flowmeter to a pipeline connected on the outlet side.

A2

The paragraph on page 3, beginning on line 17:

A3

The above and other problems are solved and an advance in the art is made by the provision of a Coriolis flowmeter having a reduced flag dimension in the present invention. The Coriolis flowmeter of the present invention has flow tubes that are capable of handling large mass flow rates. The Coriolis flowmeter of the present invention does not have a conventional manifold and spacer. Instead, the spacer substantially surrounds the manifolds. This configuration reduces the cost of the flowmeter. The Coriolis flowmeter of the present invention also has a reduced flag dimension which allows the Coriolis flowmeter of the present invention to be used in areas where space is at a premium and it would be impossible to use a conventional Coriolis flowmeter having a conventional flag dimension.

The paragraph on page 3, beginning on line 32:

A4

A driver is affixed to the flow tubes at a position along the semicircular arc of each flow tube that is substantially perpendicular to a plane containing the inlet end and the outlet end of the flow tube. The driver is positioned at this point to minimize the amount of energy applied to the flow tubes by the driver to cause the flow tubes to oscillate. Drive signals are applied to the driver to cause the driver to oscillate the flow tubes at a low amplitude to reduce the stress applied to brace bars affixed to the flow tubes. The driver must also drive the flow tubes to vibrate at a frequency that is higher than conventional flow tubes.

The paragraph on page 4, beginning on line 23:

A5

A spacer is affixed to each of the manifolds to maintain the distance between the manifolds. The spacer is a structure having four sides with opposing ends affixed to the inlet and outlet manifolds. The spacer encloses a hollow cavity. This reduces the amount of material used in casting the manifold. Openings in the top side of the spacer allow the manifold to connect to the semicircular arc of the flow tubes which protrude outward from the spacer.

The paragraph on page 7, beginning on line 6:

In order to have reduced flag dimension, flow tubes 103A-103B have a substantially semicircular arc 150-150' between an inlet end 151-151' and an outlet end 152-152'. Substantially semicircular arc 150-150' reduces the flag dimension by creating a continuous curve in flow tubes 103A-103B. Substantially semicircular arc 150-150' must be used in order to allow flow tubes 103A-103B to be of a sufficient diameter to facilitate large flow rates of material flowing through Coriolis flowmeter 5. In order to connect flow tubes 103A-103B serially into a pipeline, inlet manifold 102 and outlet manifold 102' may have a substantially 90 degree bend in a flow path to direct flow from the pipeline into substantially semicircular arc 150-150'.

The paragraph on page 7, beginning on line 15:

To achieve zero stability and to separate vibrational modes of the flow tubes 103A-103B, a first brace bar 120 and a second brace bar 121 are affixed to flow tubes 103A and 103B. First brace bar 120 is affixed to flow tubes 103A-103B proximate inlet end 151 to connect flow tubes 103A and 103B to control oscillations of flow tubes 103A-103B. Second brace bar 121 is affixed to flow tubes 103A-103B proximate outlet end 152 to connect flow tubes 103A and 103B to control oscillations of flow tubes 103A-103B. In a preferred exemplary embodiment, first brace bar 120 and second brace bar 121 are affixed to flow tubes 103A-103B substantially 180 degrees apart from each other on substantially semicircular arc 150-150'.

The paragraph on page 7, beginning on line 24:

Driver 104 is affixed to flow tube 103A and 103B at a position on semicircular arc 150-150' that is substantially at a midpoint between inlet 151-151' and outlet 152-152' of flow tubes 103A-103B. This position allows driver 104 to apply the greatest amount of force to flow tubes 103A-103B using the least amount of power. Driver 104 receives signals from meter electronics 20 via path 110 that cause driver 104 to oscillate at a desired amplitude and frequency. In a preferred exemplary embodiment, the frequency of a vibration is substantially equal to a first out of phase bending mode of flow tubes 103A-103B which is a higher frequency than conventional Coriolis flowmeters. In order to reduce stress from the higher frequency, it is desired to maintain a low amplitude of vibration in the preferred exemplary embodiment.

The paragraph on page 8, beginning on line 2:

In order to vibrate flow tubes 103A-103B at a high frequency and low amplitude, pick-offs 105-105' must be affixed to flow tubes 103A-103B at position where the greatest amount of vibration may be sensed in flow tubes 103A-103B. This allows pick-offs 105-105' to detect the greatest amount of effect of Coriolis forces caused by the flowing material. In a preferred embodiment, the pick-offs 105-105' are positioned at a position that is substantially 30 degrees from axises w-w'. However, the pick-offs 105-105' may be placed at a position anywhere between 25 and 50 degrees from the w-w' axises when conventional electronics are used to drive the flowmeter.

The paragraph on page 8, beginning on line 12:

FIG. 2 illustrates a spacer 200 affixed to flowmeter sensor 10. Spacer 200 maintains a constant distance between inlet manifold 102 and outlet manifold 102'. Unlike conventional spacers in Coriolis flowmeters, spacer 200 is made of minimal material. Spacer 200 has square ends 190-191 on opposing sides. In a preferred exemplary embodiment, the square ends 190-191 are cast as square plates in manifolds 102-102'. Four walls represented by walls 201-204 connect each edge of square bases 190-191 to form an enclosure. Openings 210 allow substantially semicircular arcs 150-150' of flow tube 103A-103B to protrude from spacer 200.

The paragraph on page 8, beginning on line 21:

FIG. 3 illustrates a casing 300 for enclosing flow tubes 103A-103B (Shown In FIG. 1). Casing 300 is a structure having a hollow inside that fits over flow tubes 103A-103B and is affixed to spacer 200 in some manner such as a weld, or nuts and bolts. Casing 300 prevents atmosphere from entering the enclosure.

In the ABSTRACT

A Coriolis flowmeter sensor capable of handling large mass flow rates and having a reduced flag dimension. In order to have a reduced flag dimension, the flow tubes are formed to have a substantially semicircular arc between an inlet and an outlet. Brace bars, connected to the flow tube proximate the inlet and outlet, separate the frequencies of vibration in the flow tubes. Pick-offs are positioned upon the substantially semicircular arc of the flow tube at a position that allow the pickoffs to maximize detection of low amplitude, high frequency vibrations of the flow tubes required to have a reduced flag dimension.

In the Drawings

The applicants have amended FIG. 1 by adding reference numbers 110 and 151'. Red-inked drawings showing the amendments are included as are new formal drawings.